Computational Imaging

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R&D Grass Valley Cameras

Agenda

- Real Time Imaging
  - 4k almost for free
  - HDR
  - Lens corrections
- Post processing
  - Coded aperture

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4K ALMOST FOR FREE

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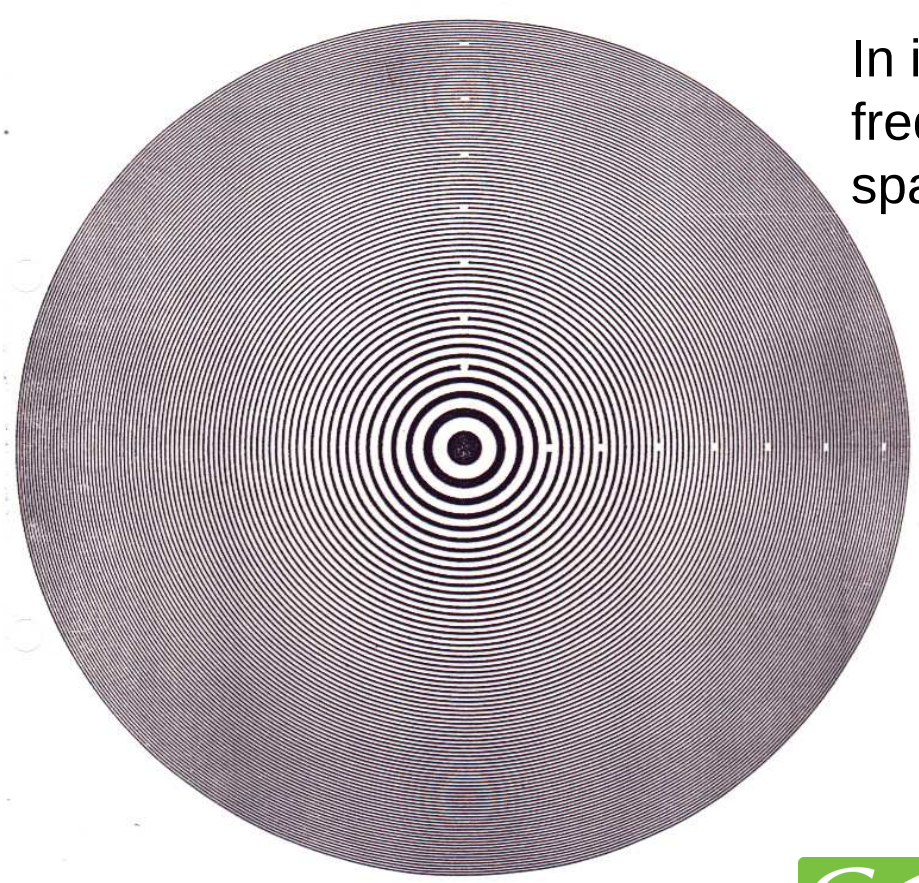
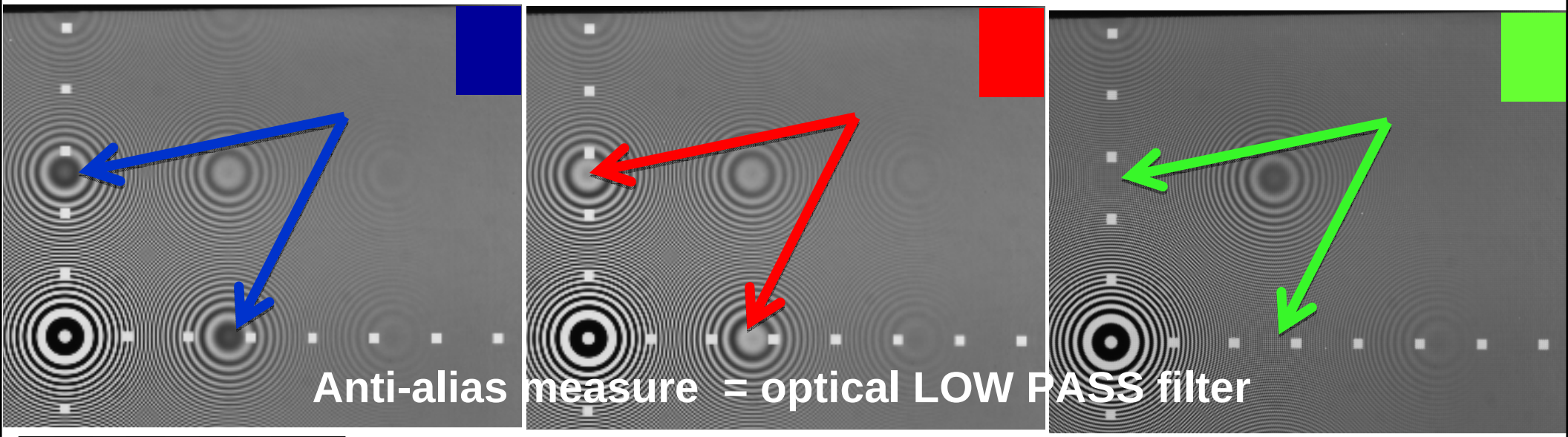
Bayer and the zone chart

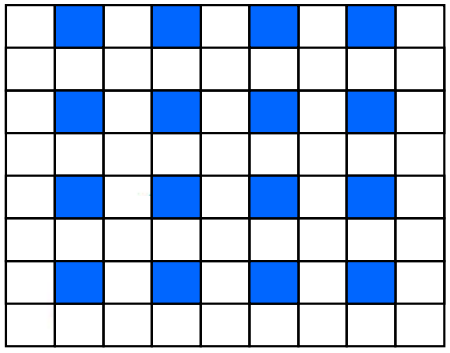


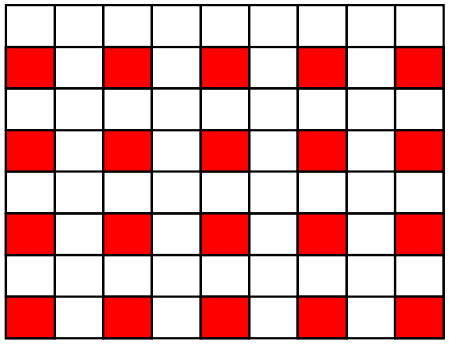
In imaging there are always frequencies violating Nyquist (both spatial and temporal) causing aliasing

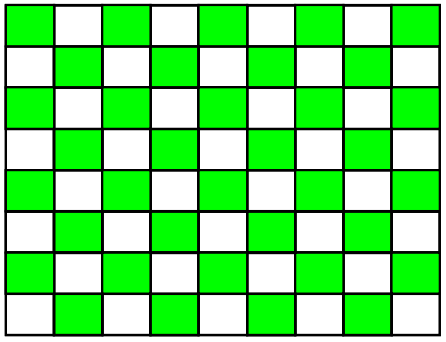
no MTF without Alias

Bayer and aliasing in B, R, G









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Bayer and Computational Imaging

- 4k single imager
  - 2Mpixels R, after computation 8Mpixels R
  - 2Mpixels B, after computation 8Mpixels B
  - 2x2Mpixels G, after computation 8Mpixels G
- Up-convert 4:4:4 HDTV to 4kp60 @ almost for free
  - Single imager 4k : Pixels per line 2x2k = 4k
  - 3 imager HDTV : Pixels per line 3x2k = 6k

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HDR

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The beauty of CMOS

- HDR built-in
  - Low AC flare
  - Low DC flare
- On the + side: better blacks
- On the – side: more lens corrections needed

How to **map** 140dB in 8-10bit.....need for more bandwidth/bits

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CORRECTABLE LENS ABERRATIONS

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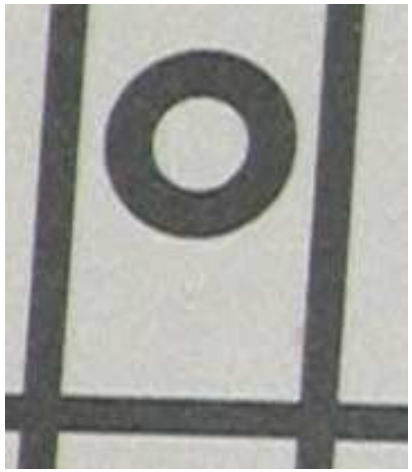
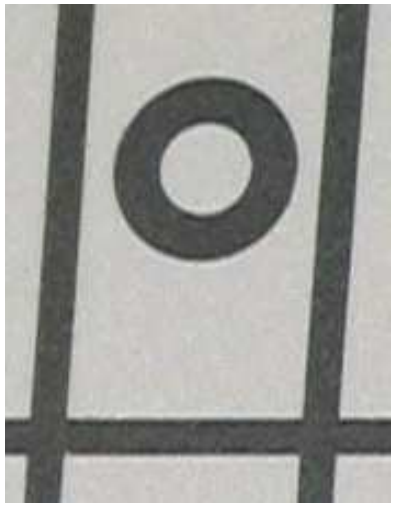
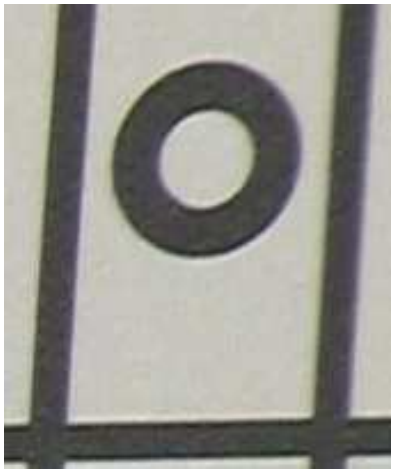
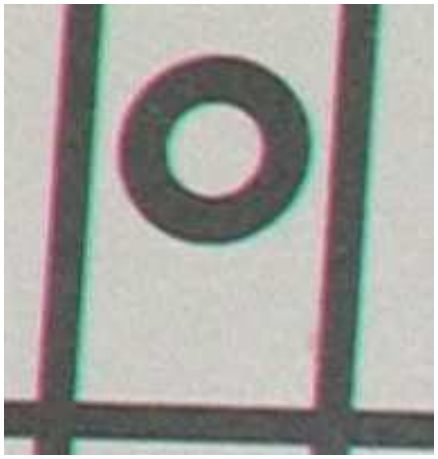
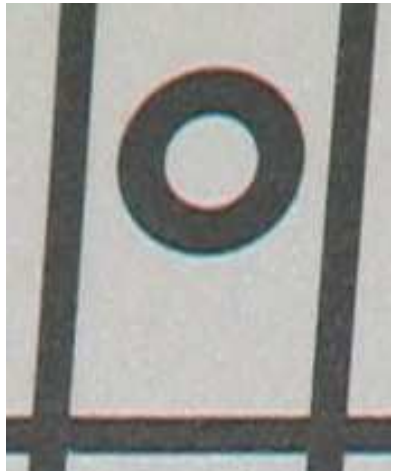
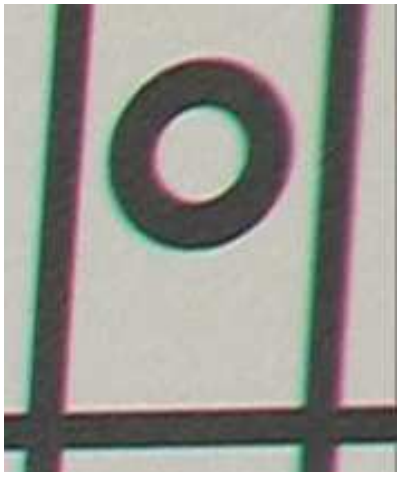
2nd benefit: “Deblurring”

The next challenge: correcting blue fringing

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INTENTIONAL LENS ABERRATIONS

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Coded aperture

- *Image and Depth from a Conventional Camera with a Coded Aperture*
  - Anat Levin, Rob Fergus, Frédo Durand, William Freeman,
  - MIT CSAIL, SIGGRAPH 2007
  - **http://groups.csail.mit.edu/graphics/CodedAperture**

Coded aperture

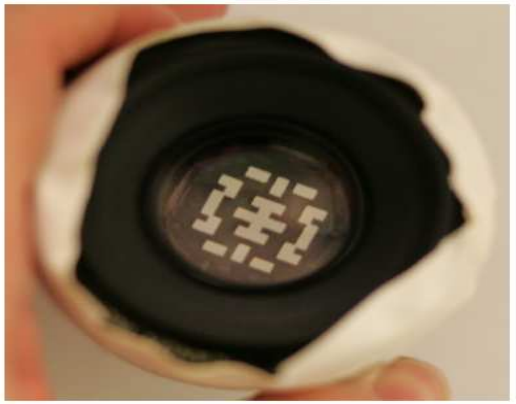
Add a disk between the lens and the camera!

http://groups.csail.mit.edu/graphics/CodedAperture

Coded aperture

Make defocus patterns different from natural images: it is about zeros in the spectrum

Conventional aperture

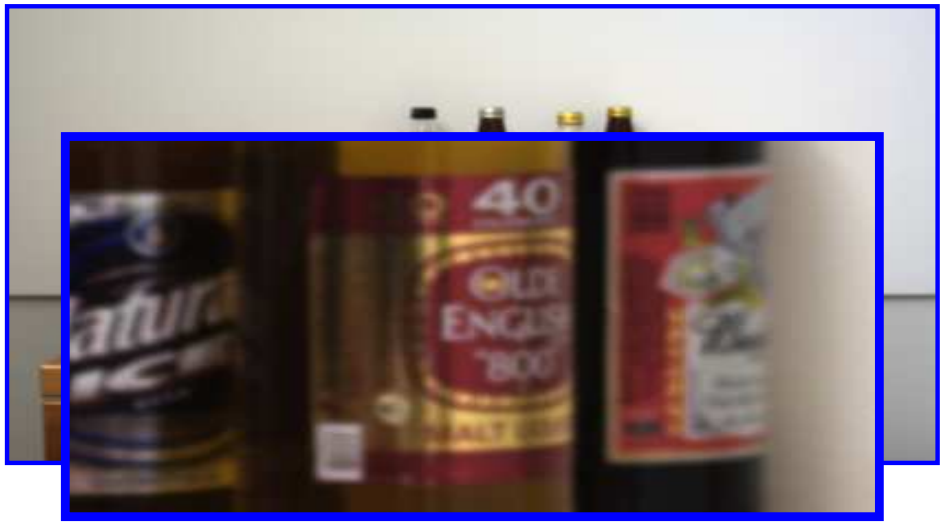


coded aperture

http://groups.csail.mit.edu/graphics/CodedAperture

Output #1: Depth map

Single input image:



Output #2: All-focused image

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Application: Digital refocusing

http://groups.csail.mit.edu/graphics/CodedAperture

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Conclusion

- From computational point of view:
  - Intensity dependent Mapping (HDR)
  - Position dependent Scaling (Chromatic aberration corrections)
  - Interpolation (4k single-imager and 2k three-imager)
  - De-convolution (Coded aperture)
- Filling the bit-pipe with HDTV, 4k, 8K and frame rates
  - 12 Gbps @ 8kp15 = 4kp60 = 1080p240 = 720p480

The next 5 years or so

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Moore's law
SD, HD, 4k, 8k
SNR, HDR, WCG, HFR
Filling the bit-pipe

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